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Report to Congressional Requesters

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AIR TRAFFIC CONTROL

Ineffective Management Plagues $1.7-Billion Radar Program

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United States
General Accounting Office
Washington, D.C. 20548

Information Management and
Technology Division

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May 31, 1990

The Honorable Frank R. Lautenberg
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
United States Senate

The Honorable William Lehman
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
House of Representatives

At the request of your offices, we reviewed the Federal Aviation Administration's (FAA) Mode Select (Mode S) air traffic control surveillance and communication program. FAA is buying Mode S systems to provide more accurate aircraft location information and to allow controllers and pilots to exchange data. In 1984, FAA contracted to buy 137 Mode S systems to replace many existing beacon radars[1] and provide data communications to the air traffic control system. In October 1988, FAA decided to spend over $1 billion for 259 additional Mode S systems. As agreed with your offices, we assessed FAA's (1) progress in developing and testing the initial 137 systems and (2) justification for the additional 259 systems. Our objectives, scope, and methodology are contained in appendix I.

Results in Brief

Twenty years after proposing the concept and over 5 years after awarding a $221 million production contract to buy 137 Mode S systems, FAA has spent about $145 million without receiving the first system. The agency now expects to install fully capable systems at operational sites beginning in April 1993—5 years later than planned.

This situation occurred because FAA used a high-risk acquisition strategy and did not remedy contract problems when they arose. FAA did not adequately develop or test the Mode S system before awarding the production contract, which contributed to later technical problems. Although officials knew of these problems as early as February 1987, FAA did not act aggressively to correct them until June 1989. At that time, FAA warned that the contract might be terminated if the contractor did not

[1]Beacon radars calculate aircraft location using an electronic signal sent to aircraft and a return signal sent by aircraft.

solve the problems. Subsequently, 10 months passed before FAA and the contractor agreed on an approach to overcome the problems. This approach modified the contract to delay system deliveries and to allow interim delivery of less capable systems. Even as these changes were being negotiated, however, additional schedule delays occurred, creating uncertainty about whether continuing the contract will lead to timely system deployment.

Further, FAA plans to spend over a billion dollars to buy 259 more systems even though it has been unable to deploy any of the initial 137 Mode S systems. FAA has not justified this investment because it did not properly analyze requirements, consider alternatives, or evaluate benefits and costs.

To ensure that FAA has chosen the best approach to resolve Mode S contract difficulties requires an independent evaluation of the economic, operational, and technical risks involved in completing the Mode S contract. FAA also needs to cancel plans to buy additional systems and properly evaluate requirements, alternatives, costs, and benefits. Finally, FAA needs to correct the underlying internal control weaknesses which allow these problems to occur.

Background

FAA's mission is to promote the safe, orderly, and expeditious flow of air traffic. Controllers use aircraft location and flight plan information and discussions with pilots to be sure that controlled aircraft are safely separated. A nationwide network of FAA-owned radio towers provides voice communications between controllers and pilots. Aircraft location and altitude—surveillance information—are provided by two types of FAA-owned radars. FAA search radars determine aircraft location by sending electronic signals that are reflected back to the radar receiver. These radars, however, cannot determine the aircraft's identification or altitude. Beacon radars send an electronic signal that is received by aircraft equipped with a transponder. The transponder automatically responds, and this response is used to determine the aircraft's identity, location, and altitude. Although search radars detect aircraft with or without transponders, beacon radars can locate only transponder-equipped aircraft.

Mode S responds to a 1969 Department of Transportation study that concluded that more accurate aircraft location information and the ability to send data between controllers and pilots would benefit the air

traffic system. A 1972 study confirmed that (1) a new surveillance technique—monopulse processing—improved accuracy and reduced interference, and (2) sending signals to and from individual aircraft—discrete addressing—virtually eliminated interference and provided a channel to communicate data to and from individual aircraft. In 1976, FAA contracted to build and test three engineering models. In 1984, the agency awarded a fixed-price incentive fee production contract—estimated to cost $221 million for 137 Mode S systems—to a joint venture between Westinghouse and what is now the UNISYS Corporation. At that time, FAA planned to buy 60 additional systems and to evaluate alternatives to replace remaining beacon systems. In October 1988, FAA decided to replace all beacon radars with Mode S, and planned to award a contract for 259 additional Mode S systems. FAA estimates costs to deploy all 396 Mode S systems will exceed $1.7 billion.

Prior Reports Questioned FAA's Procurement Practices

We have issued several reports criticizing FAA procurement practices and citing Mode S as a major system for which a premature production contract was awarded. Government procurement guidance calls for major systems to be developed and tested before an agency awards a production contract. In 1983, we questioned FAA's plans to buy Mode S, recommending that it further test the system before proceeding.[2] We believed the problems were serious because the engineering models could not meet important requirements, such as handling many aircraft in a small area, and because the contractor had stated that new software and a new computer processor would be needed to meet requirements. FAA, however, dismissed these concerns, asserting that current hardware technology and new software would satisfy its requirements.

In 1987, we reported that FAA had not used prudent procurement practices when awarding major contracts including Mode S.[3] We noted that FAA had not adequately developed and tested systems before committing to production. In response, the Department of Transportation agreed to require FAA to justify, develop, document, and test systems before awarding future production contracts.

[2]FAA's Plans To Improve The Air Traffic Control System: A Step In The Right Direction, But Improvements and Better Coordination Are Needed (GAO/AFMD-83-34, Feb. 16,1983).

[3]Aviation Acquisition: Improved Process Needs to be Followed (GAO/RCED-87-8, Mar. 26, 1987).

FAA Has Not Resolved Mode S Problems

Over 5 years after FAA awarded the contract, technical problems continue to prevent Mode S deployment. FAA now expects the contractor to deliver the first fully capable system to an operational location in April 1993, 5 years later than planned. Although FAA officials repeatedly expressed concern about the contractor's lack of progress, the agency did not take formal steps to require the contractor to resolve problems until June 1989. Ten months later, in April 1990, FAA and the contractor agreed to modify the contract to further extend the delivery schedule and allow interim deployment of systems which will not meet all FAA requirements. However, even as FAA was negotiating these modifications, additional delays occurred and the contracting officer temporarily stopped payments until the contractor made additional progress. Progress payments resumed in April 1990, when the contract was modified.

Technical Problems Have Led to Extensive Mode S Deployment Delays

As shown in table 1, delivery schedules have repeatedly slipped. In April 1988, FAA and the contractor agreed to delay delivery of the first system by 21 months to complete the system design and conduct additional contractor tests. This change followed concerns expressed by FAA officials as early as February 1987 that delays were occurring in developing the software. In March 1989, the schedule was extended another 15 months primarily to overcome continuing software development problems. This change followed additional warnings that difficulties were being encountered designing software to meet key operational

Table 1: Mode S Program Delays

		Delivery of first full system for FAA testing		Delivery of first system to an operational site		Delivery of last system to an operational site	
Date	**Contract action**	**Scheduled date**	**Months delayed**	**Scheduled date**	**Months delayed**	**Scheduled date**	**Months delayed**
October 1984	Award	April 1987	•	May 1988	•	January 1992	•
April 1988	Modification #21	January 1989	21	April 1989	11	December 1992	11
March 1989	Modification #28	April 1990	36	October 1990	29	March 1994	26
April 1990	Modification #32	February 1992[a]	58	April 1993[b]	59	August 1995	43

[a]Under this contract modification, an interim system with a limited software capability is scheduled to be delivered for testing to the FAA Technical Center in Pomona, New Jersey, in August 1991.

[b]An interim system is to be delivered to the first operational site in March 1992.

requirements, coding software to operate as required, and integrating different software modules to work together.

FAA officials agree the program has encountered serious technical difficulties which have led to extensive schedule delays. Mode S contractor officials also agreed that unexpectedly complex problems have led to delays and noted that the hardware and software had not been designed or developed when FAA awarded the contract. In addition, contractor correspondence with FAA cited inadequate agency contract specifications as a factor contributing to delays.

Management Actions Were Not Effective

Although development problems had existed for over 2 years and FAA had agreed to two contract extensions, FAA officials did not fully appreciate the severity of the problems until April and May 1989. At that time, (1) the contractor reported that delivery milestones—agreed to 1 month earlier—could not be met because of continuing software development problems; (2) an FAA technical representative at the contractor's plant reported that system hardware needed extensive changes to meet requirements, and (3) an FAA support contractor reported that contractor progress reports had been misleading. This information led FAA to issue a cure notice in June 1989. As provided for in Section 49.402-3 of the Federal Acquisition Regulation, a cure notice is an early step in formal government proceedings to terminate a contract when the contractor appears to be unable to perform. FAA's notice asked the contractor for detailed information to ensure that a system meeting contract requirements would be delivered.

In response, the contractor assured FAA that it could overcome technical problems and eventually deliver a system meeting requirements. The contractor proposed that FAA allow interim deployment of some less capable systems followed by fully capable systems. For example, although the contract requires the system to track 700 targets, the interim system would only track 400 targets.

In April 1990—10 months after issuing the cure letter—FAA and the contractor modified the contract to further extend the delivery schedule and to allow the delivery of interim systems. FAA officials explained that this approach will allow the agency to begin testing less capable Mode S systems in order to deploy a working system at the earliest date. Thus, FAA believes the contractor can overcome remaining problems and that continuing the contract is in the best interest of the government. Current

plans call for 18 interim systems to be deployed at selected sites beginning in March 1992. The first full performance system is to be delivered to an operational site in April 1993, and by August 1995 the interim systems are to be upgraded to full capability and all 137 systems are to be deployed.

FAA's decision to continue the contract, however, might not be the best approach. The contractor has still not delivered a working system and, even as FAA negotiated the recent contract changes, additional delays occurred. Between January and March 1990, FAA revised the estimated Mode S delivery dates to reflect an additional 1 year schedule delay. The contracting officer also temporarily stopped making payments until the contractor made additional progress to complete the contract. As of January 1990, the contractor had incurred costs of over $177 million—about 65 percent of the $271 million contract ceiling price—and FAA had made payments totalling about $145 million.

In commenting on our report, FAA officials said they believe the agency acted effectively to deal with technical problems. These officials cited several actions FAA took to obtain early warnings of contractor problems including establishing management indicators in April 1988. This case, however, demonstrates that internal controls were not adequate to ensure that appropriate action was taken when contract problems arose, and contradicts earlier FAA assurances to Congress that the agency had strenghthened contract management practices. For example, during a February 1987 hearing before the House Appropriations Committee, Subcommittee on Transportation and Related Agencies, an FAA official conceded that contract oversight activities on a major computer contract had needed improvement, but noted that FAA had established formal management controls to identify problems early enough to enable corrective management actions. During March 1988 hearings before the same subcommittee, an FAA official testified that although the Mode S contract had encountered problems, FAA believed the contractor was then doing an "incredible" job. During March 1989 testimony, an FAA official testified that FAA anticipated that the contractor's technical progress would be good. The discovery of severe additional problems within 2 months of this testimony shows that FAA did not receive timely warnings of problems.

Spending $1 Billion for More Systems Is Not Justified

FAA may also unnecessarily spend over $1 billion to buy additional Mode S systems because it did not properly analyze requirements, alternatives, benefits, or costs. To ensure that government funds are invested wisely, procurement regulations and policies emphasize the importance of performing a rigorous analysis of mission requirements, considering a full range of alternatives, and analyzing the costs and benefits associated with each alternative.[4] FAA did not do this, believing that it did not need to do a complete analysis because the first 137 systems had already been approved. However, because FAA expects the first 137 systems to cover most controlled airspace and serve most users, additional systems may provide relatively few benefits. Thus, benefits and costs of additional systems will differ from the first systems', and a rigorous analysis of requirements, alternatives, benefits, and costs should have been performed.

Universal Data Communications Requirement Was Not Established

Although analyzing requirements is fundamental to making prudent investment decisions, FAA did not do this before deciding to buy the 259 additional systems. Specifically, FAA did not establish that providing data communications at lower altitudes is justified. It is important to determine the airspace in which data communications should be provided because economic and operational benefits depend on the number of aircraft using the services. Because most air traffic control activity takes place in higher altitude airspace, the extent to which providing data communications to lower altitude airspace will generate additional operational or economic benefits should be evaluated.

Although FAA has developed criteria to justify providing other navigation and air traffic control services at individual sites, it has not developed criteria to justify adding data communications services. Lacking criteria, FAA's System Engineering Service, which analyzed beacon radar replacement options, simply assumed data communications should be provided wherever surveillance coverage is provided. FAA officials from the Air Traffic Plans and Requirements Service, which determines requirements, confirmed that criteria to determine data communications requirements have not been established and that the agency has not formally determined that data communications should be provided wherever surveillance coverage is provided.

[4]Office of Management and Budget Circular A-109 and the Federal Information Resource Management Regulation describe the required process.

FAA asked Martin Marietta Corporation, its systems engineering and integration contractor, to conduct an analysis to support the decision to buy more Mode S systems. Although the official responsible for this analysis had recommended that FAA validate the assumption that data communications coverage should be provided wherever surveillance coverage is provided, this was not done. The analyst explained that rather than using his suggested approach, FAA System Engineering Service officials directed that the analysis focus on supporting the decision to deploy Mode S.

Alternatives Were Not Properly Evaluated

FAA also concluded that of all alternatives considered, only Mode S, by providing both increased surveillance accuracy and expanded data communications, would meet overall requirements. According to agency documents and officials, FAA initially considered: (1) a monopulse radar system, (2) a monopulse system with discrete addressing capability, (3) a monopulse system with discrete addressing and data communications (Mode S), (4) a monopulse system with discrete addressing and a separate data communications system, and (5) a combined satellite surveillance and data communications system.

FAA, however, did not fully evaluate whether separate alternatives could meet surveillance and data communications requirements independently. To illustrate, because the first two alternatives—monopulse and monopulse with discrete addressing—did not provide data communications capability, the analysis concluded that these would not meet requirements. FAA also concluded that a cost-effective satellite system able to meet both surveillance and communications requirements would not be available until well into the 21st century. Finally, it eliminated separate ground-based data communications alternatives from consideration, contending that a data communications system would be very expensive and would involve a high degree of technical risk. The agency, however, did not identify or analyze any independent satellite or ground-based data communications system before reaching this conclusion. After eliminating the other alternatives, FAA concluded that only Mode S would satisfy requirements.

Had FAA identified and separately considered alternatives to meet surveillance and data communications requirements independently, it might have reached a different conclusion. For example, monopulse systems could provide improved surveillance accuracy while reducing interference problems, and adding a discrete addressing capability could virtually eliminate interference. FAA is also exploring using satellite

technology to provide surveillance information for oceanic, low altitude, and mountainous regions. Thus, alternatives might satisfy surveillance requirements without providing data communications.

Although FAA did not evaluate independent alternatives to provide data communications, the agency is developing a data communications architecture that would use several data communication systems including ground and space-based systems. To support these efforts, FAA research programs are defining requirements and interfaces, identifying alternative technologies, and evaluating transition strategies. FAA plans to complete studies of the technical and economic feasibility of alternative space-based concepts by 1992—before contracting for additional Mode S systems.

Costs and Benefits Were Not Fully Evaluated

Although analyzing costs and benefits for a full range of alternatives is also fundamental to making investment decisions, FAA did not do so. FAA's cost analysis did not consider all alternatives and included a complete cost estimate only for the Mode S alternative. The analysis did not estimate benefits for any alternative.

FAA and Martin Marietta officials told us Mode S was the only alternative for which FAA prepared a complete cost estimate. Estimates for other alternatives were either judgmental or were not done at all. For example, the analysis estimated that a monopulse system would cost about 66 percent of a Mode S system, based chiefly on FAA and Martin Marietta officials' engineering judgment. FAA did not estimate costs for any independent ground or space-based data communications alternative.

FAA also did not estimate the benefits associated with any alternative, including Mode S. Instead, agency officials cited unquantified operational advantages expected from additional systems such as: consistent air traffic control operations, maximized data communications benefits, controller productivity gains, and enhanced safety. However, many of these advantages are actually quantifiable benefits that FAA has included in calculating benefits for other systems. We have also previously pointed out that FAA needs to develop both quantitative and qualitative benefit information before selecting system alternatives.[5]

[5]Air Traffic Control: FAA Should Define the Optimal Advanced Automation System Alternative (GAO/IMTEC-89-5, Nov. 30, 1988).

Limited Analysis Is Inadequate

FAA officials agreed that the agency has not established data communications coverage requirements, performed a full analysis of alternatives, or estimated costs and benefits. During our review, FAA officials contended, however, that the analysis was adequate. They argued that (1) expanding data communications would provide significant benefits to small private aircraft and increased communications reliability for the air traffic control system, (2) a separate data communications system might not be affordable to the private aircraft owners who would be the primary beneficiaries of expanded coverage, (3) a monopulse system with discrete addressing is needed to eliminate interference problems, and (4) adding data communications to a discrete addressing system increases costs by only about 15 percent. They also argued that the agency would prepare a complete benefit/cost analysis to obtain Department of Transportation approval to buy additional Mode S systems.

It is questionable, however, whether a proper analysis would conclude that FAA should buy 259 more systems. FAA expects the first 137 systems to achieve large economic and operational benefits by providing reliable data communications in most controlled airspace. The 259 additional systems would provide some benefits by expanding services into airspace which predominantly serves small private aircraft and by adding redundant coverage at higher altitudes. However, FAA estimates that only a small percentage of private aircraft owners will buy data communications equipment and FAA did not analyze the extent to which it needs redundant coverage. Also, the largest association representing private aircraft owners believes few of its members will invest in data communications equipment and has recommended that Congress not fund Mode S systems to replace the remaining beacon radars.

We were also unable to identify any FAA analysis to support the assertion that the agency needs monopulse with discrete addressing to reduce interference. In fact, according to several agency technical studies, deploying the first 137 systems could significantly reduce all forms of interference. Further, replacing the remaining beacon systems with monopulse systems that do not have discrete addressing could further reduce interference. Moreover, additional processing—called degarbling—could be done to resolve interference problems. As a result, the remaining amount of interference might not be significant, especially at locations with low volumes of air traffic.

Finally, because FAA had already selected Mode S as the preferred alternative, the planned benefit/cost analysis was only to have compared

benefits and costs associated with deploying Mode S to leaving the remaining beacon radars in place. FAA did not plan to analyze benefits and costs of other alternatives because other alternatives had already been eliminated. At the conclusion of our review, we discussed these plans with the Martin Marietta official responsible for overseeing benefit/cost analyses. This official agreed that a complete analysis of a full range of alternatives should be performed.

In commenting on our report, FAA and Department of Transportation officials said the agency has not decided whether to acquire additional Mode S systems and that it intended to perform extensive cost/benefit, trade-off, and alternative analyses prior to seeking authorization to proceed. Although we are encouraged by the agency's commitment to conduct this analysis, we disagree that the analysis was previously planned. At the conclusion of our review, FAA management officials argued that the additional Mode S systems were fully justified and that the agency did not plan to analyze requirements or alternatives before seeking approval to proceed.

FAA officials have previously stated, in February 1987 testimony before the House Appropriations Committee, Subcommittee on Transportation and Related Agencies, that the agency had instituted stringent controls to prevent unjustified requirement changes from being incorporated into its plans. However, the fact that FAA management allowed this $1-billion acquisition to be included in the agency's plans without a proper analysis reveals material weaknesses in FAA's process to justify major system investment decisions. These weaknesses could lead to substantial unjustified spending. Specifically, FAA's internal procedures for approving changes to its national airspace system investment plans do not identify what analysis is needed to justify buying additional systems. This case also confirms Office of Management and Budget concerns, expressed in October 1989, that FAA controls over major system procurements may not be adequate to deal with the large procurement budgets planned for the next several years.

Conclusions

The process FAA used to buy the first 137 Mode S systems and its decision to buy 259 more systems is fundamentally flawed. FAA prematurely awarded a production contract and then did not act aggressively to remedy deficiencies when development problems occurred. Ten months after notifying the contractor that it might terminate the contract, FAA modified the contract, extending deliveries for the third time. This change also allows the contractor to deliver interim systems which do

not meet all FAA requirements. Given both the continuing delays and the large additional investment needed to complete the contract, it remains uncertain whether continuing the contract and accepting interim systems is the most effective approach.

FAA's unjustified decision to invest over $1 billion to replace the remaining beacon radars also confirms that basic flaws exist in FAA's process to justify major system procurement decisions. Contrary to prudent procurement practices, FAA's analysis did not properly evaluate requirements, alternatives, costs, or benefits and was predisposed to conclude that Mode S was the optimal alternative. This is not just a question of FAA's failure to complete administrative paperwork because (1) additional data communications coverage using Mode S might not generate enough operational or economic benefits to justify the cost of providing the expanded services and (2) Mode S might not be the optimal solution. Although the agency plans to conduct another benefit/cost study before obtaining Department of Transportation approval to proceed, these plans did not call for an analysis of requirements or consideration of a full range of alternatives.

Recommendations

Given the continuing Mode S development problems and the fact that FAA has not justified its decision to spend an additional $1 billion, the Secretary of Transportation must act decisively to correct the problems. Therefore, we recommend that the Secretary:

- Independently evaluate the economic, operational, and technical risks involved in continuing the Mode S contract. Based on the results of this evaluation, the Secretary should direct the FAA Administrator to take appropriate and timely action to ensure that additional government funds are not wasted.
- Direct the FAA Administrator to cancel plans to replace remaining beacon radars with Mode S and to perform a thorough analysis of requirements, alternatives, benefits, and costs. If the analysis supports replacing remaining beacon systems with Mode S, no decision to acquire additional Mode S systems should be made until the system is demonstrated to work and provide anticipated benefits.
- Report FAA's contract administration and major system procurement processes as containing material internal control weaknesses under the Federal Managers' Financial Integrity Act (31 U.S.C. 3512).

Agency Comments and Our Evaluation

We obtained the views of responsible agency and contractor officials on the results of our work. We included their comments where appropriate. We also obtained formal oral comments from Department of Transportation officials on a draft of this report. They commented that FAA's Mode S contract management actions have been effective, but agreed that FAA should analyze the operational and technical risks associated with completing the contract. They also agreed that FAA had not justified a decision to acquire additional Mode S systems and agreed that a complete analysis of alternatives to replace remaining beacon radars should be done. The officials disagreed with our recommendation that the Department report internal control weaknesses, stating that FAA had begun to review management controls to ensure that major system acquisitions were effectively managed. In each of these cases, the Department asserted that FAA had already planned actions which would be responsive to our recommendations. Finally, FAA and Department officials requested that we recognize FAA actions to improve the process, including designating an Executive Director for Acquisition.

Although we agree that FAA should be commended for initiating actions to review management controls and improve its management of major system acquisitions, we are concerned that the Department of Transportation may still not recognize the seriousness of existing problems. Suggesting that FAA already planned to deal with our recommendations implies that FAA management was effective in identifying and responding to problems. These planned actions, however, were not in place when we discussed the results of our review with responsible FAA management officials in March 1990. At that time, FAA argued against (1) assessing the risks involved in completing the contract, and (2) analyzing Mode S requirements and alternatives before seeking approval to buy additional systems. FAA also modified the contract on April 17, 1990, 6 days after receiving our draft report recommending an independent analysis of the economic, operational, and technical risks involved in continuing the contract. Although FAA now plans to review technical and operational risks, the decision to continue the contract will limit the alternatives available to the government. We continue to believe that FAA's internal control weaknesses are serious and must be reported under the Financial Managers' Financial Integrity Act.

As arranged with your offices, unless you publicly announce the contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. We will then send copies to the Secretary of Transportation, the FAA Administrator, and other interested parties; and

will make copies available to others on request. This report was prepared under the direction of JayEtta Z. Hecker, Director, Resources, Community, and Economic Development Information Systems, who can be reached at (202) 275-9675. Other major contributors are listed in appendix II.

Ralph V. Carlone

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Abbreviations

FAA	Federal Aviation Administration
GAO	General Accounting Office
IMTEC	Information Management and Technology Division
MODE S	Mode Select

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Objectives, Scope, and Methodology

At the request of the Chairmen of the House and Senate Committees on Appropriations, Subcommittees on Transportation and Related Agencies, we reviewed FAA's efforts to implement the Mode S surveillance and data communications program. As agreed with their offices, our objectives were to evaluate (1) FAA's progress in developing and testing the first 137 Mode S systems and (2) its justification for plans to acquire 259 additional systems.

To evaluate the agency's progress in developing Mode S, we examined program office and contractor documents describing development progress, problems, and actions being taken to resolve problems. These documents included program status reports and technical assessments. We interviewed FAA officials as well as personnel from (1) Martin Marietta, FAA's system engineering and integration contractor; (2) MSI, a support contractor; and (3) Westinghouse and UNISYS Corporations.

To determine the current status of testing and future test plans, we reviewed agency test policies as well as test plans, procedures, and results. We discussed the adequacy of completed and planned tests with FAA program office, technical center, and support contractor personnel. We also discussed test results and plans with Mode S contractor officials. Our evaluation was limited because few tests have actually been conducted. In addition, because of program changes, many detailed test plans and procedures have not yet been prepared.

To evaluate plans to acquire additional Mode S systems, we reviewed FAA and support contractor documents describing the acquisition. We reviewed historical information to document changes in plans and justifications. We also reviewed underlying working papers used to develop the justification, including the extent to which FAA evaluated requirements and properly considered a full range of alternative solutions. Finally, we discussed the justification to acquire additional systems with agency officials and with support contractor officials who actually developed the justification. Although the scope of our effort was adequate to conclude the decision was not justified, we did not perform a complete analysis of alternatives.

Our work was performed between December 1988 and April 1990 at FAA headquarters and the Martin Marietta Corporation in Washington, D.C.; at FAA's Technical Center in Pomona, New Jersey; and at the Mode S joint venture contractor's facilities of Westinghouse Corporation in Baltimore, Maryland, and UNISYS Corporation in Paoli, Pennsylvania. The views of agency and contractor officials were obtained during the course

of our work and their comments have been incorporated where appropriate. In addition, at the completion of our review, we discussed the report's key facts, conclusions, and recommendations with FAA officials. Finally, we obtained formal oral comments from Department of Transportation officials on a draft of this report. These comments and our analysis are also included in this report. We conducted this review in accordance with generally accepted government auditing standards.

Major Contributors to This Report

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